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Projection to 2030 for setting emission reduction targets in the Southern Mediterranean Partner countries

An approach with a Business-as-Usual scenario

Brigitte Koffi, Alessandro K. Cerutti, Greet Janssens-Maenhout

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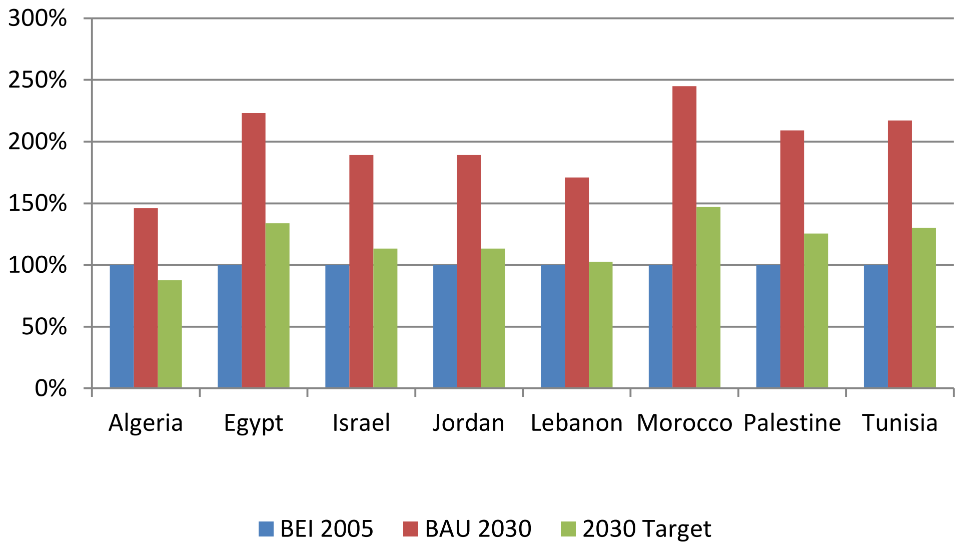

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Authors

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Abstract

The Covenant of Mayors for the Members of the Southern Neighbourhood (CoM South), which was launched in 2012, required an adaptation of the Covenant of Mayors (CoM) methodology to the local situation and a complete revision of the CoM Guidebook "How to develop a Sustainable Energy Action Plan (SEAP)". Such an adaptation was made by tackling in a more appropriate way the specific institutional and economic situation of the Southern Mediterranean countries involved in the initiative. This specific approach for CoM South Mediterranean countries is based on the commitment to a reduction of CO_2 emissions with reference to a Business As Usual (BAU) emission scenario, instead of to the past or current emission situation.

Adopting a Business As Usual approach allows the signatories to fulfil their aspiration for further development, by including social and economic progress in the calculation of the emissions projections. In a previous report dated 2013, a scientific region-specific BAU projection was applied to the calculation of CO_2 and CO_2 equivalent emission coefficients for 2020 for the Mediterranean area, using European Commission tools and data, from the CIRCE (Climate change and impact research: the Mediterranean environment) integrated project. In the process of extending the Covenant of Mayors action from the 2020 to the 2030 target year as part of the new integrated "Covenant of Mayors for Climate and Energy", an update and extension of the emission projections and coefficients for the current members of the Southern Neighbourhood (Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine and Tunisia) are provided in this report.

1. Introduction

1.1 The Covenant of Mayors South towards 2030

The Covenant of Mayors (CoM) initiative, which was launched in 2008, is the mainstream European movement involving local authorities voluntarily committing to meet and exceed the European Union (EU) Greenhouse gases emission reduction objectives, by committing to a minimum CO_2 emissions reduction of 20% by 2020 and 40% by 2030 (as compared to 1990) through increasing energy efficiency and the use of renewable energy sources in their territories. In order to demonstrate such commitment, the Covenant signatories (towns, cities and regions) must prepare and submit an Action Plan which is based on the results of the Baseline Emission Inventory (BEI) and includes all the planned measures to be implemented in order to achieve the emission reduction target (Bertoldi et al., 2010). Since its launch in January 2008, more than 6,900 local authorities from EU countries have committed to reduce their CO_2 emissions by at least 20% by 2020, of which more than 5,400 have already submitted their Sustainable Energy Action Plan (SEAP) (Kona et al., 2016).

In 2012, the Covenant of Mayors was extended towards the EU Eastern neighbourhood through the Covenant of Mayors East programme and towards the southern Mediterranean countries, through the Covenant of Mayors South Mediterranean programme. As of November 2016, the 8 countries of the CoM Southern Partnership (hereafter “CoM South Mediterranean countries”) are the following:

- Algeria
- Egypt
- Israel
- Jordan
- Lebanon
- Morocco
- Palestine
- Tunisia

The situation in these countries is quite different from that in the EU. In particular, some are less politically stable and therefore less inclined to draw up sustainable energy projects involving longer term investments. Some face lack of resources, absence of national framework for climate and energy policy, and all have an aspiration for strong economic growth, which the CoM would like to direct towards a green growth.

Because these countries are facing societal and economic challenges, the Covenant of Mayors for the Members of the Southern Mediterranean Partner Countries required an adaptation of the Covenant of Mayors methodology and guidebook for EU Countries (Bertoldi et al., 2010) appropriate to their situation (Cerutti and Janssens-Maenhout, 2013; Cerutti et al., 2014). Consequently, the reduction target should be calculated in comparison to the emission levels forecasted by a Business As Usual (BAU) scenario for the target year rather than on the basis of past or present-day emissions (as for CoM EU signatories). Starting from present data, **the BAU reference scenario projects the evolution of energy and emission levels forward to the target year, under the hypothesis of continuing current trends in population, economy, technology and human behaviour, without the implementation of additional emission reduction actions**. In support to the CoM South programme, BAU coefficients that allow estimating the CO_2 emissions in 2020 were calculated by the Joint Research Centre (JRC) of the European Commission (Cerutti and

Janssens-Maenhout, 2013) for the CoM South signatories, based on JRC in-house datasets and tools. The methodology used accounts for differences in individual country trends and focuses on the sectors, which are targeted in the CoM South initiative (buildings, transport and waste).

As part of the "New Integrated Covenant of Mayors for Climate and Energy", launched in October 2015, a more ambitious CO_2 emission reduction target has been set for the year 2030, corresponding to 40% emission reduction as a minimum target. This next step for the Covenant of Mayors towards 2030 also defines renewed commitment(s) and a shared post-2020 vision in order to tackle interconnected challenges. In the frame of the new Covenant, the signatory does not only commit to reducing carbon emissions across its territory but also to increasing its resilience to the impacts of climate change, through adaptation measures.

In this process of extending the Covenant of Mayors action towards the 2030 target year, we provide in this report an update and extension of Cerutti and Janssens-Maenhout (2013) to 2030, with revised BAU emission projections and coefficients. It is worth noting that local authorities can use either their own methodology to estimate their emissions in 2030 or the BAU emission projections and coefficients provided in this report. However, the second option is highly recommended in order also to ensure consistency at country level.

1.2 The CoM methodology for Southern Partnership

Since October 2015, local authorities joining the new Covenant of Mayors for Climate and Energy initiative commit to submit a Sustainable Energy and Climate Action Plan (SECAP) within two years following the formal signing. As for the SEAP, the SECAP is based on a Baseline Emission Inventory (BEI) but it also includes a Climate Risk & Vulnerability Assessment(s) (RVAs) which consists of adaptation considerations to be put into relevant policies, strategies and plans. Both elements (BEI and RVAs) provide an analysis of the current situation and serve as a basis for defining a comprehensive set of actions that local authorities plan to undertake in order to reach their climate mitigation and adaptation goals. To elaborate and implement a successful SECAP, a signatory should also mobilise civil society and adapt the built environment, including allocation of sufficient human resources, in order to undertake the necessary actions. The CoM Signatories also commit to monitor and report on their SECAP implementation every two years after its submission, and to include the preparation of a Monitoring Emission Inventory (MEI) every 4 years.

Current and future CoM South Mediterranean countries joining the new Covenant have to fulfil the same general requirements, but benefit from specific adaptations of the CoM methodology, as explained and underlined in the following two paragraphs.

Baseline and Monitoring Emission Inventories :

The BEI covers the CO_2 emissions that occur due to energy consumption in the territory of the local authority. The following sectors (often referred to as key sectors of activity) are strongly recommended to be included (Bertoldi et al., 2010):

- municipal buildings, equipment and facilities (incl. public lighting);
- tertiary (non-municipal) buildings, equipment and facilities;
- residential buildings;
- urban road transportation (including municipal fleet, public transport, private transport).

The energy-related emissions coming from other sectors and some greenhouse gases (GHG) emission sources not related to energy consumption (e.g., sources of CH_4 and N_2O) can also be included in the BEI/MEI, notably if the SECAP foresees measures for them. In the case of the CoM

South programme, two main additional sectors are recommended in order to encounter the specific situation of the CoM South Mediterranean countries: the “Solid Waste treatment” and the “Wastewater treatment”, both of which are responsible for CH_4 and N_2O emissions. Finally, the local authority may also wish to include actions aiming to reduce the CO_2 emissions on the supply side (e.g. development of the district heating network, wind farms, Photovoltaic systems, etc…). In this case, local energy (electricity, heat/cold) production has to be included in the BEI/MEI.

For signatories in Southern Partnership countries, it is suggested that a more recent year (rather than 1990) can be chosen in order to be more in line with the current economic situation and for which the most comprehensive and reliable data can be provided (Cerutti and Janssens-Maenhout, 2013). Although there is no specific recommendation, the period between 2001 and 2010 is considered the more suitable due to a better availability of international datasets and applicability of the BAU coefficients.

Sustainable Energy and Climate Action Plan:

The purpose of the SECAP is to define, to describe and to estimate quantitatively greenhouse gas (GHG) reduction measures. A SECAP should contain both short term actions and mid-long term strategies. The key sectors of activity are the ones, whose inclusion in the BEI is "strongly recommended" (see above). Moreover, the local authority is expected to play an exemplary role, by implementing measures on its own buildings, facilities and fleet.

As explained in the introduction, the CoM South Mediterranean countries can decide to calculate the reduction target (40% by 2030) in relation to forecasted 2030 BAU emissions (see Figure 1). It has to be noted that setting a 'per capita' target on the basis of a BAU scenario is not allowed because the BAU scenario, whether general or custom-made for a city, already includes assumptions about the future trend in the population. Signatories who already have a SEAP 2020 and are willing to join the new CoM 2030 are requested to continue reporting on the 2020 targets using the BAU 2020 coefficients provided in Cerutti and Janssens-Maenhout (2013), while starting long-term planning to 2030. This should be done based on the same methodological approach and same baseline year for both 2020 and 2030 target years, in order to ensure that 2030 commitment is a continuation of efforts towards 2020 target. Changing the BEI year should only be made in exceptional circumstances, when it is not possible to compile a consistent time-series from BEI to 2030 using the original BEI year.

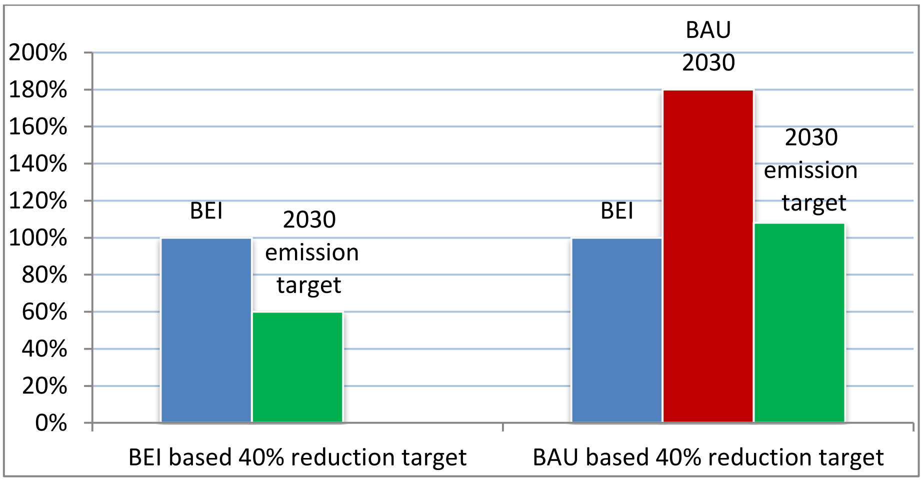

Figure 1. 2030 emission target when applying a 40% reduction to the BEI (left) compared to the BAU based approach (right) as described in this report.

2. The Business-As-Usual Scenario

Several studies estimate GHG emissions at the global scale according to a BAU scenario (e.g. IPCC, 2005; IPCC 2007; van Vuuren et al., 2009). Therefore, global scale comparisons with the proposed method can be made and detailed discussions of this issue can be found in Janssens-Maenhout et al. (2012). The Business as Usual scenario used here to calculate future CO_2 and CO_2 equivalent (CO_2-eq) emissions in CoM South Mediterranean countries considers a situation where no further climate and air pollution policies are implemented beyond what is in place after 2005. This means that calculated energy consumption from 2005 to 2050 is driven by population and economic growth alone and not by energy efficiency/climate change policies. Moreover, the combustion technologies/abatement measures per region are assumed not to change beyond 2005. As for the 2020 forecasts (Cerutti and Janssens-Maenhout, 2013), the projections use global growth rates, taking into account historical trends in Maghreb (Algeria, Morocco, Tunisia) and Mashreq (Egypt, Israel, Jordan, Lebanon) countries from 1990-2005. The advantage of these projections is that they are built for all countries equally with one single methodology, consistently applied. Moreover the projections are done for all sectors, energy-related and non-energy related sectors (Solid waste treatment) and Wastewater treatment). The latter are of particular importance when including non-CO_2 gases such as CH_4 and N_2O.

2.1 Data and models used

The EDGARv4.2 emission database[1] was used in the frame of the EU CIRCE (Climate change and impact research: the Mediterranean environment) research project (Doering et al., 2010) to calculate the EDGAR-CIRCE global inventory of CO_2, CH_4 and N_2O (and other air pollutants) anthropogenic emissions, from fossil fuel and biofuel combustion, industrial processes and the production and usage of solvents, agriculture and waste treatment. BAU emissions projections[2] were then calculated for CIRCE using growth rates from the POLES (Prospective Outlook for the Long term Energy System) model (Russ et al., 2007), which provided 2005-2050 activity data for the main energy sectors (residential, transport, ships, aviation, transformation and refineries) starting from the EDGAR-CIRCE dataset. The POLES model is a macro-economic model based on partial energy equilibrium, which contains technologically-detailed modules for energy-intensive activities (power generation, iron-steel, aluminium and cement production, and transportation) and can simulate energy demand scenarios until 2050 on world-scale (for 47 different regions), using one single oil market and three regional gas markets. Trends in agriculture, land use and waste were provided from an IMAGE model scenario that is compatible with the POLES baseline and climate stabilization scenarios used for CIRCE, and this scenario was used to build CoM South BAU projections. The IMAGE model (Integrated Model to Assess Global Environment) from the MNP (Netherlands Environmental Assessment Agency) comprises an Energy-Industry System, a Terrestrial Environment System and an Atmosphere-Ocean System, of which the second one produces projections of agricultural land-use change, crop production and animal elevation. Also sectors such as 'use other products' (including solvents) use the population growth rate from IMAGE (van Vuuren et al., 2009) for the growth rates of the emissions. For the sectors 'solid waste disposal' (main sector: waste) emissions of all substances are also scaled with the population growth rate, while emissions of 'wastewater treatment' are scaled with growth rates of sewage. In the 'agriculture' sectors, the emissions are scaled with the specific growth rates of the corresponding emitters (for instance, N_2O soil emissions are scaled with the growth rate in fertilizer use, combined with the growth rate of crop residues; emissions of 'manure management' are scaled with the growth rates of animal waste and 'agricultural waste burning' emissions with the growth rates of CH_4 emissions from agricultural waste burning). Indirect emissions are assumed constant in time.

[1] EDGAR database, version 4.2. http://edgar.jrc.ec.europa.eu

[2] See also Cerutti and Janssens-Maenhout (2013) for a more detailed description of the BAU scenarios and calculations

2.2 *The 2030 BAU emission projections*

For all but one countries of CoM Southern partnership (see section 1.1), projections using CIRCE dataset were calculated for the period 2009-2030, using 2005 as the baseline year, in order to extend calculations from activity data from EDGAR v4.2 that are only available up to 2008. The BAU projections do not include Palestine, for which activity data from international statistics are too scarce to allow a comprehensive emission estimate. Nevertheless, annual BAU coefficients are provided in Chapter 3, derived from emission trends per activity sector in neighbouring countries and Palestine population statistics.

Emissions in the BAU scenario were calculated separately for individual gases (here CO_2, CH_4 and N_2O) and converted into CO_2-equivalents, based on their Global Warming Potential (GWP), which expresses the contribution to global warming of the specific greenhouses as compared to carbon dioxide. Throughout this background document, the 100-years GWP values as used in the Kyoto Protocol are applied (IPCC, 1995). Furthermore, as with the CoM main methodology (Bertoldi et al., 2010), emissions are accounted considering exclusively those sectors which mayors can influence significantly, also for the BAU projections. For the CoM Southern partnership countries, four key activity sectors are considered, which are referred as "CoM South BAU sectors" hereafter: *Residential, Transport, Solid waste treatment and Wastewater treatment.*

2.2.1 CO_2, CH_4 and N_2O emissions trends

- **CO_2 emissions**: the most important CoM South BAU sectors are *Residential* and *Transport* (figure 2). The expected trend to 2030 is for a significant increase in emissions in both sectors: compared to 1990, an increase of 86 Mt CO_2 (+241%) and an increase of 62 Mt CO_2 (+120%) are estimated in the *Residential* and *Transport* sectors, respectively. The country breakdown of the BAU projections suggests overall increases of 83 Mt CO_2 (+197%) and of 65 Mt CO_2 (+163%) in the Mashreq (figure Annex I.1) and of Maghreb (figure Annex I.2) regions, respectively.
- **CH_4 emissions**: the most important sector is *Solid waste treatment*. This sector alone is estimated to show an increase of + 441% (+23 Mt CO_2-eq) by 2030 compared to 1990 (figure 3). By comparison, CH_4 emissions in other sectors are relatively stable, such as in the *Residential* sector (+ 0.05 Mt CO_2-eq corresponding to only 2% more emissions). The country breakdown of the data shows that the CH_4 emissions would increase from 1990 to 2030 by +16 Mt CO_2-eq (+176%) in the Mashreq countries (figure Annex I.3) and of 14 MtCO_2-eq (+174%) in Maghreb ones (figure Annex I.4).
- **N_2O emissions**: the most important sectors are *Wastewater treatment* and *Residential*. Emissions from *Wastewater treatment* are estimated to account for more than the half of all N_2O emissions in CoM sectors (figure 5). Nevertheless the largest increase is expected to occur in the *Residential* sector, with +247 % of N_2O emissions (+1.49 MtCO_2-eq) in 2030 compared to 1990. The country breakdown of N_2O emissions projections, for the Mashreq and Maghreb regions is reported in figure Annex I.5 and figure Annex I.6 respectively.

Considering these results, it is reasonable to expect a significant role for non-energy sectors (*solid waste treatment* and *Wastewater treatment*) and secondary gases (CH_4 and N_2O) in reaching 2030 emission reduction targets. As a consequence, it is highly recommended to signatories to the Southern partnership of the CoM, to take into consideration actions in these two key sectors and, consequently, to include them in their BEI.

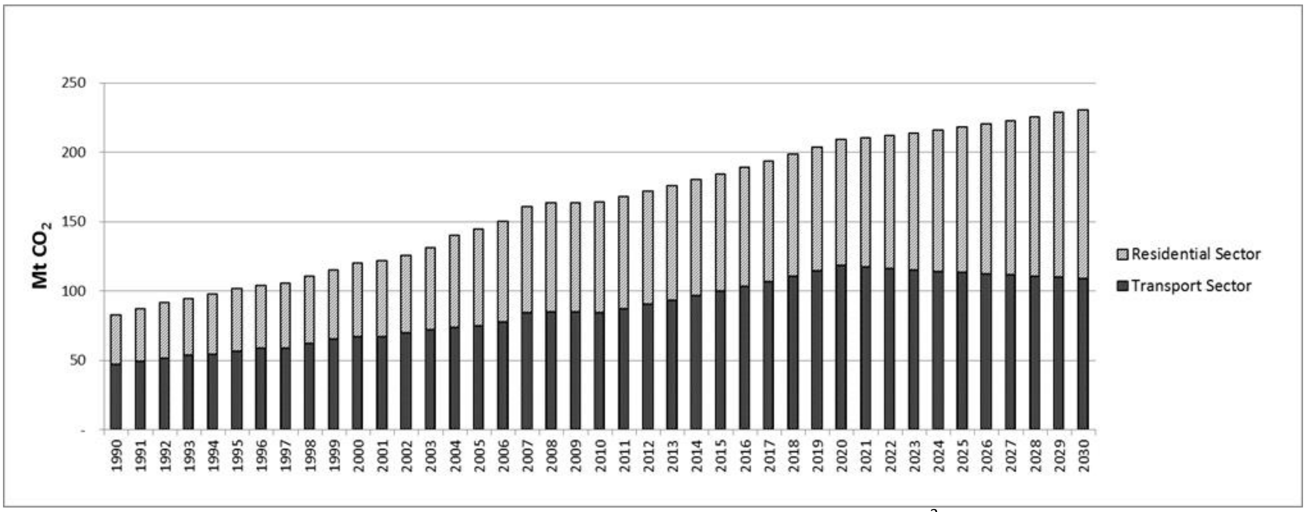

Figure 2. CO_2 emissions (expressed in Mt CO_2) in CoM South Mediterranean countries[3] for the *Residential* and *Transport* sectors to 2030

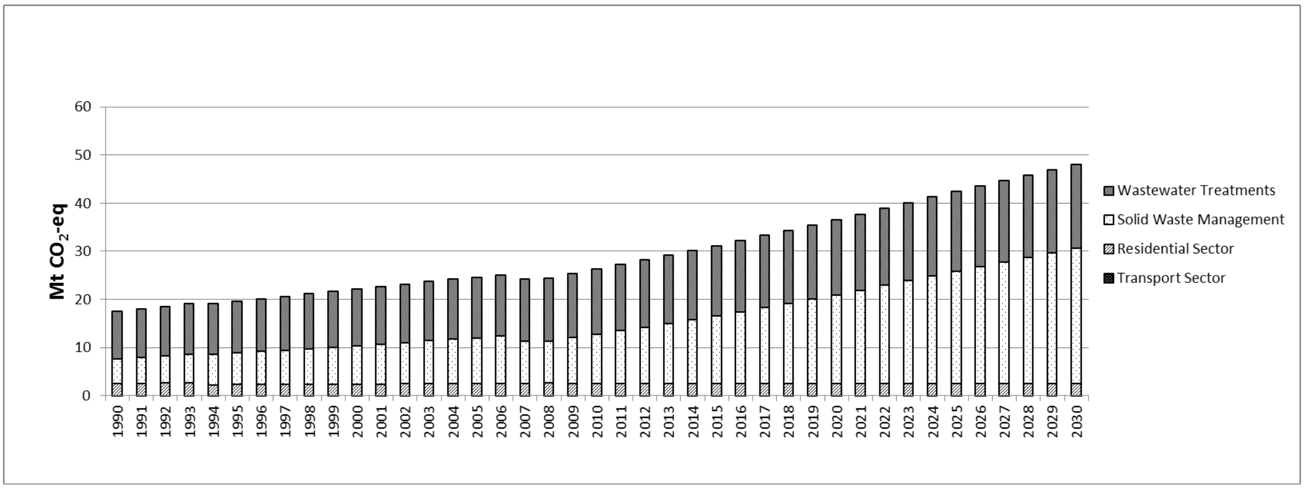

Figure 3. CH4 emissions (expressed in Mt CO2-eq) in CoM South Mediterranean countries3 for CoM South BAU sectors

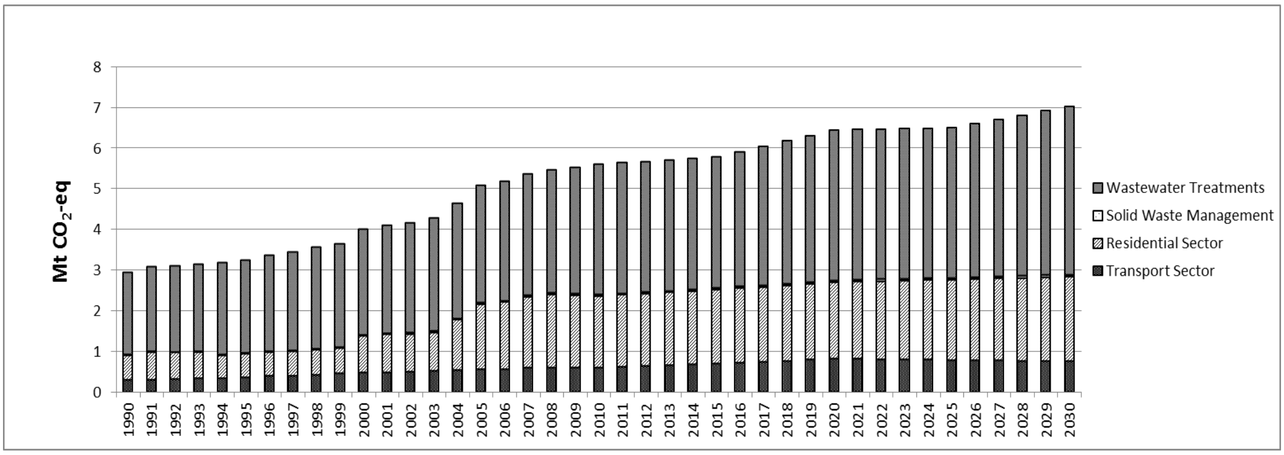

Figure 4. N_2O emissions (expressed in Mt CO2-eq) in CoM South Mediterranean countries3 for CoM South BAU sectors

[3] CoM South Mediterranean countries as defined in section 1.1. However, Palestine could not be included because activity data from international statistics are too scarce for this country.

2.2.2 GHG emission trends

The 1990 to 2030 GHG emission increase (figure 5) for all CoM South Mediterranean countries except Palestine is estimated as +183 Mt CO_2-eq (+178%), with major contributions from the *Residential* (+88 Mt CO_2-eq) and *Transport* (+63 Mt CO_2-eq) sectors. Nevertheless the biggest relative increase occurs in *Solid waste treatment* (+440% of CO_2-eq emissions) while *Wastewater treatment* also represents an important source of emissions. The country breakdown of GHG emissions projections, for the Mashreq and Maghreb regions is reported in figure Annex I.7 and figure Annex I.8 respectively.

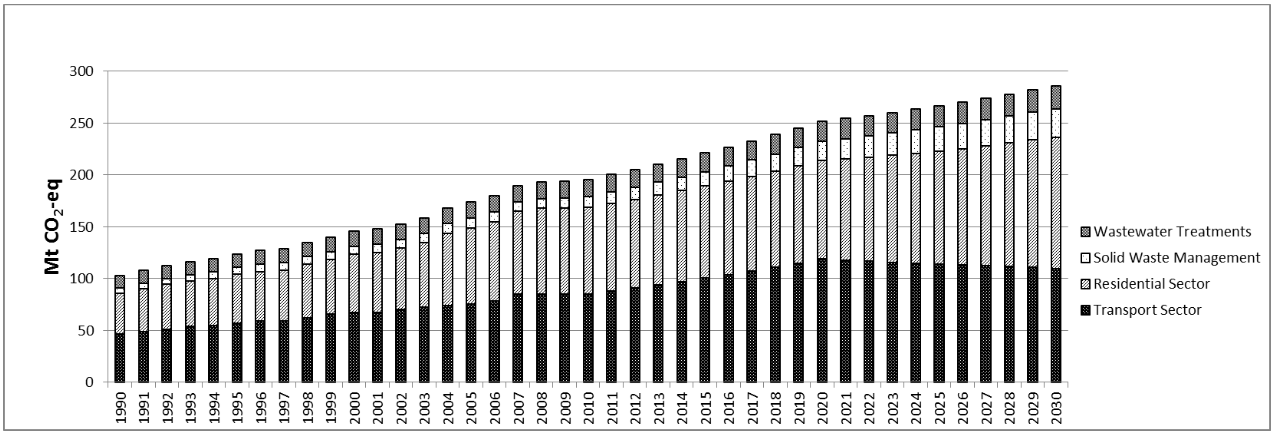

Figure 5. GHG emissions (expressed in Mt CO_2-eq) in CoM South Mediterranean countries[4] for CoM South BAU sectors

The contributions from the individual gases to the total GHG emissions are shown in figure 6. As expected, CO_2 is the main contributor to the absolute 1990-2030 CO_2 increase (+148 Mt CO_2). It is also the gas with the biggest increase in CO_2-eq emissions (+180%), just followed by CH_4 (+175%).

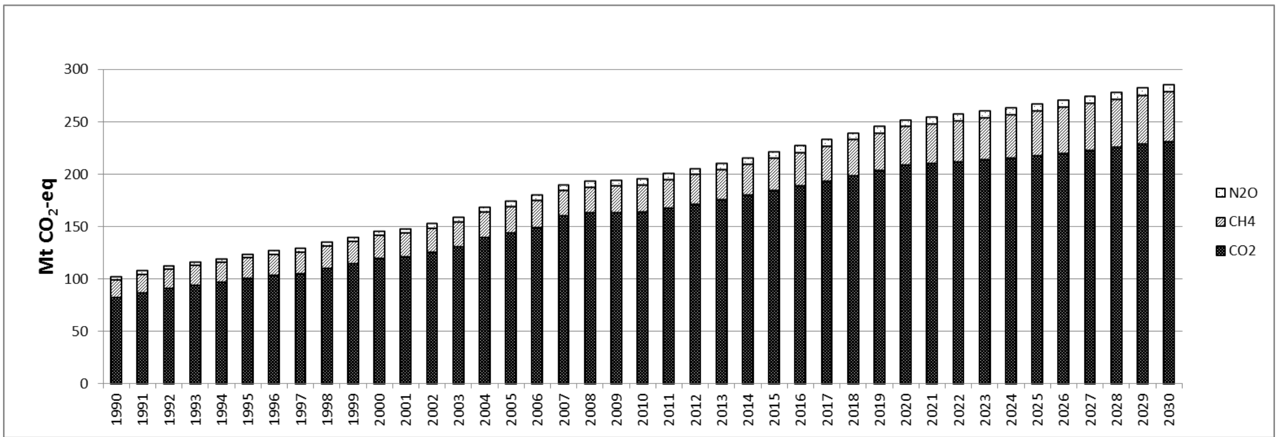

Figure 6. Individual gas breakdown of GHG emissions (expressed in Mt CO2-eq) in CoM South Mediterranean countries4 for the CoM South BAU sectors

According to these projections, a significant increase in emissions is expected under the BAU scenario in CoM South BAU sectors (table 1): CO_2 emissions are expected to increase by at least a factor 2 over the 1990-2030 period. Nevertheless, the increase related to the first period of the study (1990-2008) is higher than that projected for the second period (2009-2030) for most of the countries (excluding Lebanon and Tunisia) and especially for Algeria, Egypt and Morocco.

Table 1. Emissions increase in CoM-South BAU sectors for the South Partnership Countries in periods 1990 -2008, 2008-2030 and in the whole timeframe.

Emission increase	1990-2008		2008-2030		Total (1990-2030)	
COUNTRY	CO_2	CO_2-eq	CO_2	CO_2-eq	CO_2	CO_2-eq
Algeria	+84%	+80%	+9%	+21%	+101%	+118%
Egypt	+116%	+98%	+28%	+37%	+177%	+171%
Israel	+102%	+98%	+69%	+73%	+241%	+242%
Jordan	+76%	+81%	+78%	+80%	+214%	+226%
Lebanon	+60%	+59%	+78%	+81%	+186%	+188%
Morocco	+109%	+93%	+64%	+69%	+244%	+225%
Tunisia	+86%	+65%	+74%	+68%	+222%	+178%

Projected emissions per capita were also calculated using UNDP World Population Prospects data (UNDP, 2013), EDGAR v4.2 emissions up to 2010 and BAU assumptions up to 2030 (Tables 2 and 3). It is important to remind here that these emissions refer exclusively to the 4 CoM South BAU sectors (see section 1.3) and are therefore significantly lower than emissions per capita from all activities. Average emission increases per capita of +54% CO_2 (+55% of CO_2-eq) and +76% of CO_2 (+70% of CO_2-eq) are calculated for the Mashreq (Egypt, Israel, Jordan, Lebanon) and Maghreb (Algeria, Morocco, Tunisia) countries, respectively. Therefore also considering emissions per capita, the effort in reducing GHG appears clearly worthy. However, it should be noted that setting a 'per capita' target on the basis of a BAU scenario is not possible: BAU-based reduction targets must be calculated based on the absolute emission projections.

Table 2. Overview of CO_2 emissions per capita (tCO_2/cap.) calculated at national level for the CoM South Mediterranean countries (not including Palestine) in period 1990 -2030 for the CoM-South BAU sectors only.

	CO_2 emissions per capita calculated from EDGAR v4.2 and UNDP World Population Prospects					Estimated using BAU assumptions
COUNTRY	1990	1995	2000	2005	2010	2030
Algeria	0.87	0.79	0.81	1.03	1.11	1.02
Egypt	0.43	0.47	0.53	0.60	0.65	0.64
Israel	2.18	2.74	2.88	2.68	2.67	3.41
Jordan	1.28	1.20	1.30	1.50	1.27	1.64
Lebanon	1.13	1.75	1.55	1.46	1.29	2.03
Morocco	0.54	0.64	0.77	0.84	0.91	1.22
Tunisia	0.58	0.71	0.81	0.88	0.91	1.26

Table 3. Overview of GHG emissions per capita (tCO_2-eq/cap.) calculated at national level for the CoM South Mediterranean countries(not including Palestine) in period 1990 – 2030 for the CoM South BAU sectors only.

	CO_2-eq emissions per capita calculated from EDGAR v4.2 and UNDP World Population Prospects					Estimated using BAU assumptions
COUNTRY	1990	1995	2000	2005	2010	2030
Algeria	1.03	0.96	0.98	1.21	1.31	1.31
Egypt	0.58	0.62	0.68	0.77	0.81	0.84
Israel	2.46	3.03	3.19	2.98	2.98	3.86
Jordan	1.44	1.36	1.50	1.71	1.48	1.91
Lebanon	1.32	1.95	1.76	1.66	1.51	2.38
Morocco	0.70	0.79	0.93	1.01	1.10	1.50
Tunisia	0.76	0.90	1.02	1.10	1.05	1.42

3. Annual BAU coefficients to estimate 2030 emissions

3.1 *The BAU coefficients for the CoM South Mediterranean countries*

Emissions projections from the POLES model applied to the CoM South BAU sectors (see Section 2.1) can be used to calculate annual National Coefficients to be applied to the Baseline year emissions in order to estimate the 2030 BAU emissions in the different CoM South Mediterranean countries. The BAU coefficients are calculated using a two-stage calculation approach:

- For each year and country, national BAU factors (Annex II) are first calculated as the ratio between the projected emissions in 2030 and the emissions in the given year. The resulting BAU factors per country are shown in figures 7 and 8, only taking into account CO_2 emissions (trends for all GHG emissions are similar, therefore not shown). The closer the base year is to 2030, the closer factor approaches 1 (the factor for 2030 is mathematically equal to 1). For Palestine, the coefficients are based on those of Israel for the energy production-related sectors (residential) and on those of Jordan for the transport and waste sectors (the annual emission shares per sector were estimated by averaging those of Israel and Jordan.

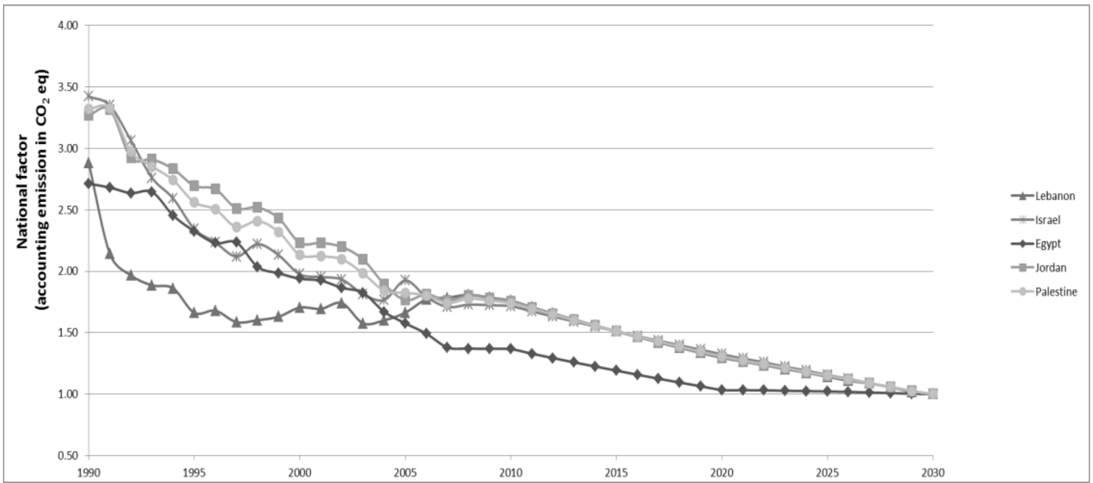

Figure 7. 1990-2030 BAU factors in CoM South Mediterranean countries in the Mashreq region.

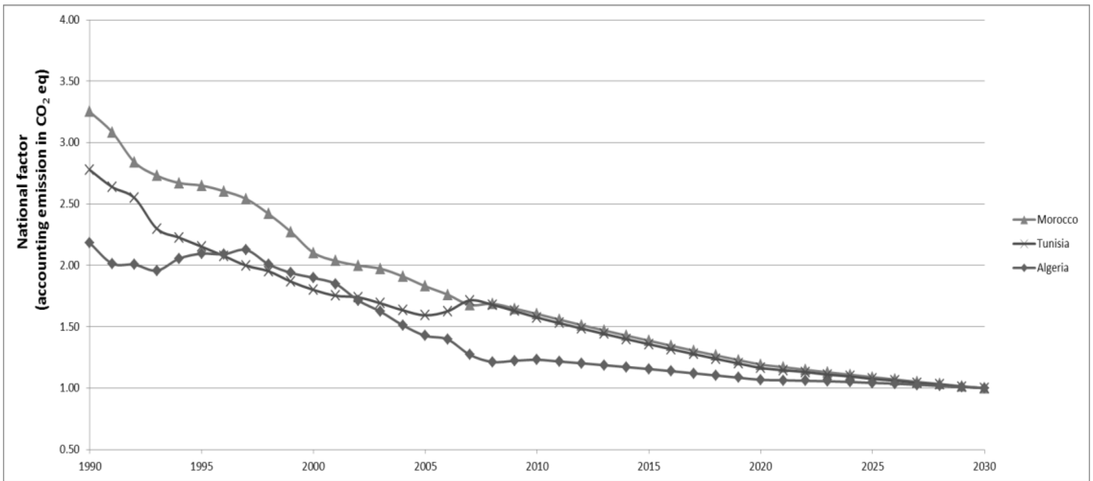

Figure 8. 1990-2030 BAU factors in CoM South Mediterranean countries in the Maghreb region.

- As explained in section 2, the emissions for the BAU scenario have been calculated on a country base. However, the focus of the CoM project is the urban dimension. Therefore, in a second step, the BAU factors are scaled to the urban dimension by using urban and rural population data from UNDP World Urbanization Prospects database, which are available every 5 years for all countries in the world (UNDP Review, 2012). Assuming that most of the increase in emissions will take place in urban places rather than in rural communities, urban specific BAU factors can be calculated as follows:

$$X_{city} = (X_{country} * Pop\_tot_{year} - Pop\_rur_{year})/Pop\_urb_{year} \quad (1)$$

where $X_{country}$ is the factor calculated for a given country and given year (see Figures 7 and 8) and X_{city} is the BAU factor adapted at the city level (also called *urban BAU factor* hereafter). Pop_tot_{year}, Pop_rur_{year} and Pop_urb_{year} are total, rural and urban populations for a given country and year, respectively.

The comparison of 2000, 2005, 2010 and 2015 BAU factors before and after correction for the urban dimension are shown in Table 4. In countries with a significant share of the population living outside urban areas, such as, notably, Egypt and Morocco, the BAU factors at national and urban levels are significantly different. For such countries, the use of urban BAU factors which account for further future urbanisation, are more suitable than the national ones. In countries with high urban population share (e.g. Israel), the two factors do not highly differ and the urban correction is not necessary, especially for those already having high per capita emissions (see Janssens-Maenhout et al. 2012 for further details on the choice between urban and national factors).

Table 4. Comparison of BAU factors before and after correction for the urban dimension in CoM-South Mediterranean countries in case of CO_2 accounting.

	National BAU Factor				Urban BAU Factor			
COUNTRY	**2000**	**2005**	**2010**	**2015**	**2000**	**2005**	**2010**	**2015**
Algeria	1.80	1.31	1.12	1.07	2.31	1.46	1.17	1.10
Egypt	1.91	1.53	1.30	1.13	3.12	2.23	1.68	1.29
Israel	1.93	1.89	1.69	1.51	2.02	1.98	1.75	1.55
Jordan	2.19	1.72	1.75	1.52	2.50	1.89	1.91	1.62
Lebanon	1.64	1.61	1.75	1.51	1.74	1.71	1.86	1.59
Morocco	2.07	1.80	1.57	1.36	3.01	2.45	2.00	1.61
Palestine	2.08	1.79	1.73	1.52	2.50	2.09	1.99	1.69
Tunisia	2.01	1.76	1.62	1.38	2.59	2.17	1.94	1.57

Applying a linear interpolation of the missing years from UNDP data, annual country-specific **BAU coefficients have been calculated for each CoM South Mediterranean country** and each year of the 2002-2030 period (see **Table 5** for CO_2 emissions accounting and **Table 6** for GHG emissions accounting). These coefficients, which include the urban correction except for Israel, are the ones to be used in the calculation of 2030 BAU emissions as explained in the following section. For local authorities only considering CO_2 emissions from the Building and Transport sectors, Table 5 should be used.

3.2 The calculation of 2030 emissions using the BAU coefficients

When preparing a 2030 BAU scenario, the CoM South Mediterranean signatories have two options: they can decide to develop their own approach or they can use the BAU coefficients provided in this report. In the latter case, which is the recommended option, they simply need to multiply the total BEI emissions in the reference year by the country-specific BAU coefficient *k* according to the following formula:

$$\text{Emission}_{BAU2030} = \text{Emission}_{BEI} * \boldsymbol{k} \tag{2}$$

where ***k*** is selected from Tables 5 or 6 according to the country, the chosen baseline year and the CO_2/GHG accounting option; Emission_{BEI} are the emissions in the baseline year, $\text{Emission}_{BAU2030}$ are the estimated BAU emissions for 2030.

The minimum emission reduction required to achieve the 40% reduction target in 2030 is given by:

$$\text{Minimum Emission Reduction}_{\text{BEI Year to 2030}} = \text{Emission}_{BEI} * \boldsymbol{k * 0.4} \tag{3}$$

The 2030 maximum allowed emission to achieve the 40% reduction target is given by:

$$\text{Maximum 2030 Emission}_{MEI2030} = \text{Emission}_{BEI} * \boldsymbol{k * (1 - 0.4)} \tag{4}$$

The 2030 maximum allowed emissions as calculated (eq. 4) for the 8 CoM South Mediterranean countries based on 2005 Baseline Emission Inventory (BEI) are shown in Figure 9 as an example. The Figure shows that, as already stated previously, the BAU-based 2030 reduction target does not necessary lead to an actual reduction of GHG emissions compared to the reference year, which is especially true when considering urban local authorities.

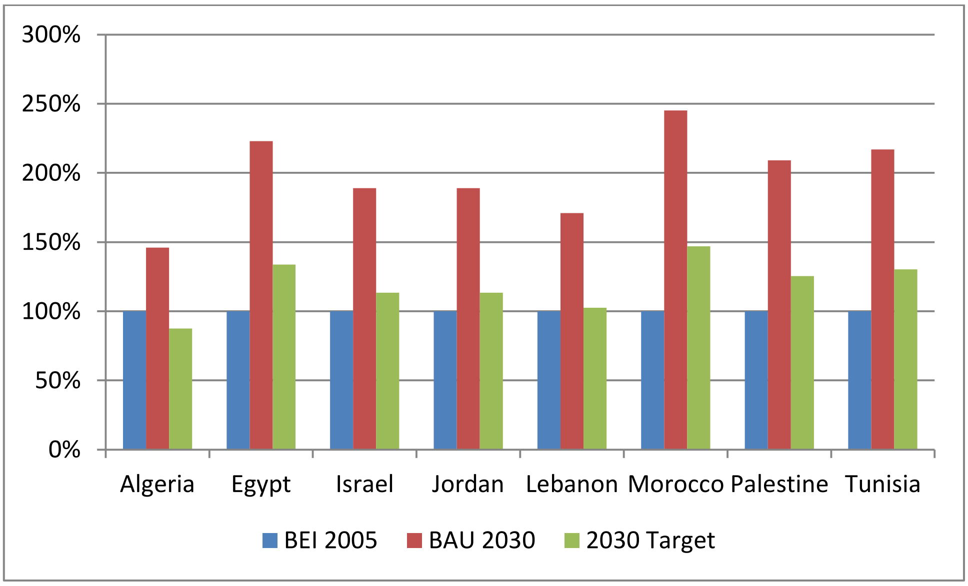

Figure 9. 2030 GHG emissions targets (in % of 2005 BEI GHG emissions) when applying a 40% reduction to the BAU 2030 emissions estimated by applying the country-specific BAU coefficients to 2005 baseline emissions.

Table 5. BAU coefficients to be applied to BEI emissions in order to calculate 2030 emissions in CoM-South Mediterranean countries in case of CO_2 emissions accounting

	BEI year													
Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Algeria	1.97	1.80	1.63	1.46	1.40	1.34	1.29	1.23	1.17	1.16	1.14	1.13	1.11	1.10
Egypt	2.76	2.58	2.41	2.23	2.12	2.01	1.90	1.79	1.68	1.60	1.52	1.44	1.36	1.29
Israel	1.90	1.77	1.73	1.89	1.75	1.67	1.69	1.69	1.69	1.66	1.62	1.58	1.54	1.51
Jordan	2.25	2.13	2.01	1.89	1.89	1.90	1.90	1.91	1.91	1.85	1.79	1.73	1.68	1.62
Lebanon	1.73	1.72	1.71	1.71	1.74	1.77	1.80	1.83	1.86	1.81	1.75	1.69	1.64	1.59
Morocco	2.79	2.67	2.56	2.45	2.36	2.27	2.18	2.09	2.00	1.92	1.84	1.76	1.68	1.61
Palestine*	2.34	2.25	2.17	2.09	2.07	2.05	2.03	2.01	1.99	1.92	1.86	1.80	1.74	1.69
Tunisia	2.42	2.34	2.26	2.17	2.13	2.08	2.03	1.99	1.94	1.86	1.78	1.71	1.64	1.57

	BEI year													
Country	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Algeria	1.08	1.06	1.05	1.03	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
Egypt	1.22	1.15	1.08	1.02	0.96	0.97	0.97	0.98	0.98	0.99	0.99	0.99	1.00	1.00
Israel	1.47	1.43	1.40	1.36	1.33	1.29	1.26	1.23	1.20	1.16	1.13	1.09	1.06	1.02
Jordan	1.57	1.51	1.46	1.41	1.36	1.33	1.29	1.26	1.22	1.18	1.14	1.10	1.07	1.03
Lebanon	1.53	1.48	1.43	1.39	1.34	1.30	1.27	1.24	1.20	1.17	1.13	1.10	1.06	1.02
Morocco	1.54	1.47	1.40	1.34	1.28	1.25	1.22	1.19	1.16	1.13	1.10	1.07	1.05	1.02
Palestine*	1.63	1.57	1.52	1.46	1.41	1.37	1.33	1.29	1.25	1.20	1.16	1.12	1.08	1.03
Tunisia	1.50	1.43	1.37	1.31	1.25	1.23	1.19	1.17	1.14	1.12	1.09	1.07	1.05	1.02

* Because activity data from international statistics are scarce for this country, the national BAU factors are based on annual emission shares per sector in the neighbouring countries, whereas the correction for the urban dimension applied to the BAU factors is based on Palestine population statistics.

Table 6. BAU coefficients to be applied to BEI emissions in order to calculate 2030 emissions in CoM-South Mediterranean countries in case of GHG emissions accounting (therefore using CO_2-eq)

	BEI year													
Country	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Algeria	2.14	1.97	1.81	1.64	1.58	1.51	1.45	1.38	1.32	1.30	1.27	1.25	1.23	1.20
Egypt	2.85	2.68	2.51	2.34	2.24	2.14	2.04	1.94	1.84	1.76	1.67	1.59	1.51	1.43
Israel	1.93	1.81	1.77	1.92	1.79	1.71	1.73	1.72	1.72	1.67	1.63	1.59	1.55	1.51
Jordan	2.30	2.18	2.06	1.94	1.94	1.93	1.93	1.92	1.92	1.85	1.79	1.73	1.67	1.61
Lebanon	1.80	1.79	1.78	1.77	1.79	1.81	1.83	1.85	1.87	1.81	1.75	1.69	1.64	1.58
Morocco	2.84	2.73	2.62	2.51	2.42	2.33	2.24	2.15	2.07	1.98	1.89	1.81	1.73	1.66
Palestine*	2.40	2.31	2.22	2.13	2.10	2.08	2.05	2.03	2.00	1.93	1.87	1.80	1.74	1.68
Tunisia	2.12	2.05	1.98	1.91	1.90	1.89	1.89	1.88	1.87	1.80	1.73	1.66	1.60	1.53

	BEI year													
Country	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Algeria	1.18	1.16	1.13	1.11	1.08	1.08	1.07	1.07	1.06	1.05	1.04	1.03	1.02	1.01
Egypt	1.36	1.28	1.21	1.14	1.08	1.07	1.07	1.06	1.05	1.05	1.04	1.03	1.02	1.01
Israel	1.47	1.43	1.40	1.36	1.32	1.29	1.26	1.22	1.19	1.16	1.12	1.09	1.06	1.02
Jordan	1.56	1.51	1.45	1.40	1.36	1.32	1.28	1.25	1.20	1.18	1.14	1.10	1.07	1.03
Lebanon	1.53	1.48	1.43	1.38	1.33	1.30	1.27	1.23	1.20	1.16	1.12	1.10	1.06	1.02
Morocco	1.59	1.51	1.45	1.38	1.32	1.28	1.24	1.21	1.17	1.14	1.11	1.08	1.05	1.02
Palestine*	1.62	1.57	1.51	1.46	1.40	1.36	1.32	1.28	1.23	1.20	1.15	1.11	1.07	1.03
Tunisia	1.47	1.41	1.35	1.29	1.24	1.21	1.19	1.16	1.14	1.11	1.09	1.06	1.04	1.02

* Because activity data from international statistics are scarce for this country, the national BAU factors are based on annual emission shares per sector in the neighbouring countries, whereas the correction for the urban dimension applied to the BAU factors is based on Palestine population statistics.

4. Conclusion and general recommendations

Adopting a Business As Usual (BAU) approach when setting their Greenhouse Gas (GHG) emissions reduction target, rather than a method based on past or present day emissions, allows local authorities to fulfil their aspiration for further development, by accounting for social and economic progress. This report provides country-specific BAU 2030 projections and coefficients for the Southern Mediterranean Partner countries (Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine and Tunisia) of the Covenant of Mayors (CoM), as part of the new integrated “Covenant of Mayors for Climate and Energy" (CoMCE). It is based on a BAU scenario previously developed for the CIRCE project (Doering et al., 2010) and applied to the calculation of 2020 BAU projections in the CoM Southern Mediterranean countries (Cerutti and Janssens-Maenhout, 2013). In the frame of CoMCE, an update and extension of the BAU projections and coefficients to the year 2030 are provided in the present report. The methodological basis and main recommendations are the following:

- The Business As Usual scenario considers the situation when no further climate and air pollution policies are implemented after 2005. This means that energy consumption from 2005 to 2050 is driven by population and economic growth rather than energy/climate change policies. The energy scenarios until 2030 are based on projections by the global POLES model and EDGAR-CIRCE database, using sector-specific growth rates and technology-based emissions from existing combustion technologies/abatement measures per region (for 47 different regions). They are then applied to the calculation of country specific 1990-2030 BAU emission factors per activity sector, taking into account the 1990-2005 national emission trends.
- The advantage of these 2030 BAU projections is that they are built for all countries equally with one single robust methodology, consistently applied. As such, local variations such as recessions, that are not representative of long term trends, do not perturb the projections to 2030. While information and tools on emission projections are available for local regions, they do not provide information that is consistent between countries. Therefore, local authorities are highly recommended to use the BAU emission coefficients produced by the European Commission, rather than developing their own BAU scenarios.
- The 2030 BAU coefficients provided in Tables 5 (CO_2 emissions) and 6 (CO_2-eq emissions), which account for differences between country evolutions and urbanisation level have been calculated from activity data for the 4 following sectors: the CoM “Buildings” and “Transport” key macro-sectors and the two additional non-energy related “Solid Waste treatment” and “Wastewater treatment”, which are optional, but recommended, sectors. They allow the local authorities of the current CoM South Mediterranean countries to estimate their 2030 emissions from these sectors, from a Baseline Emission Inventory for any given year back to 1990. For local authorities only accounting for emissions from the Buildings and Transport sectors, Table 5 (CO_2 emissions) should be used.
- Accurate, complete and up-to-date base year emissions are fundamental: the more complete the base year emissions, the less biases are present at the start of the projections. Considering the data availability in CoM South Mediterranean countries, it is recommended to choose a base year between 2001 and 2010, to possibly allow for collecting appropriate data for a representative baseline inventory.
- The signatories who already have a Sustainable Energy Action Plan to 2020 and are willing to join the new Covenant are requested to continue reporting on the 2020 targets using the BAU 2020 coefficients provided in Cerutti and Janssens-Maenhout (2013), while starting longer-term planning to 2030. This longer term planning should be done based on the same methodological approach and same baseline year for both the 2020 and 2030 targets.

This exercise could be extended to other countries. However, for newly committing countries having high per capita GHG emissions levels compared to the European mean average, the emission reduction commitment based on the BAU approach will have to be evaluated on a case by case, also taking into account the willingness and the technological level of each particular local authority (see http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts_pc1990-2014 for national emissions per capita and Janssens-Maenhout et al., 2012 for further guidelines). The standard CoM procedure based on the BEI emissions (Bertoldi et al., 2010) could be more appropriate for municipalities with a technological infrastructure that is similar to the European one.

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List of acronyms and abbreviations

BAU	Business As Usual
BEI	Base Emission Inventory
CH_4	Methane
CIRCE	Climate change and impact research: the Mediterranean environment
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
CoM	Covenant of Mayors
COP21	21^{st} session of the UNFCCC Conference of the Parties
EDGAR	Emission Database for Global Atmospheric Research
EU	European Union
GHG	Green House Gases
GWP	Global Warming Potential
HDI	Human Development index
IEA	International Energy Agency
IMAGE	Integrated Model to Assess Global Environment
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre
MEI	Monitoring Emission Inventory
MNP	Netherlands Environmental Assessment Agency
N_2O	Nitrous Oxide
POLES	Prospective Outlook on Long-term Energy Systems
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

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Annexes

Annex I. Estimated CO_2, CH_4 and N_2O annual emissions from the CoM South Mediterranean countries of the Mashreq and Maghreb regions over the 1990-2030 period

The national CO_2 emissions are estimated from the historical EDGAR-CIRCE data and the forecast scenario using the POLES model as explained in chapter 2.

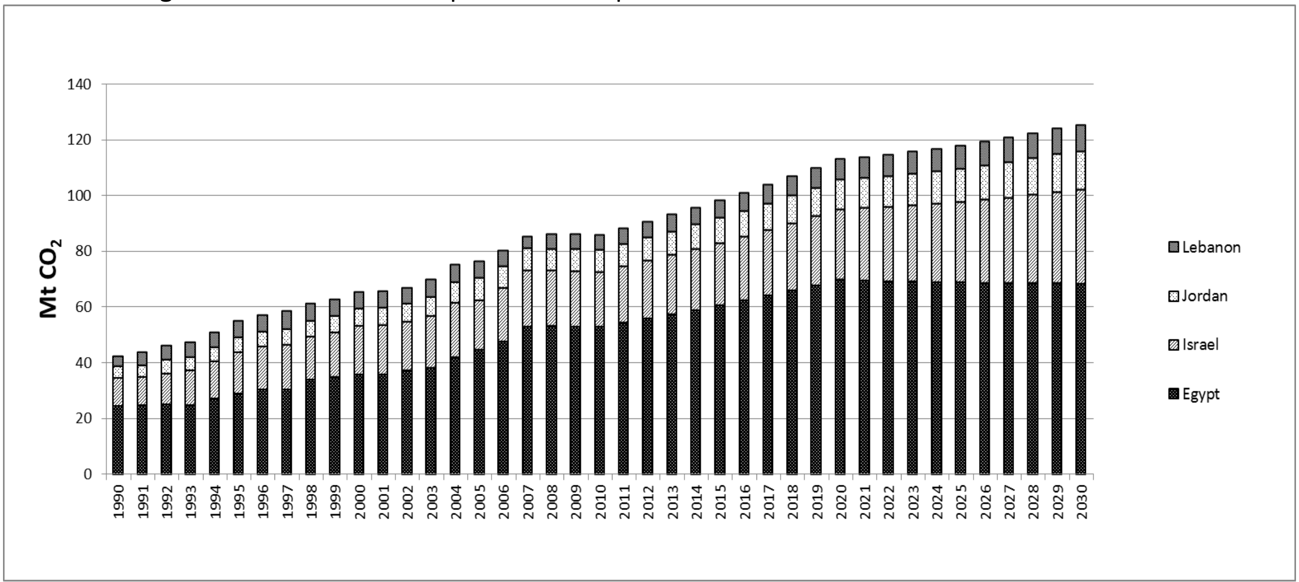

Figure AI.1. Estimated CO_2 emissions (expressed in Mt CO_2) for residential and transport sectors in Mashreq region

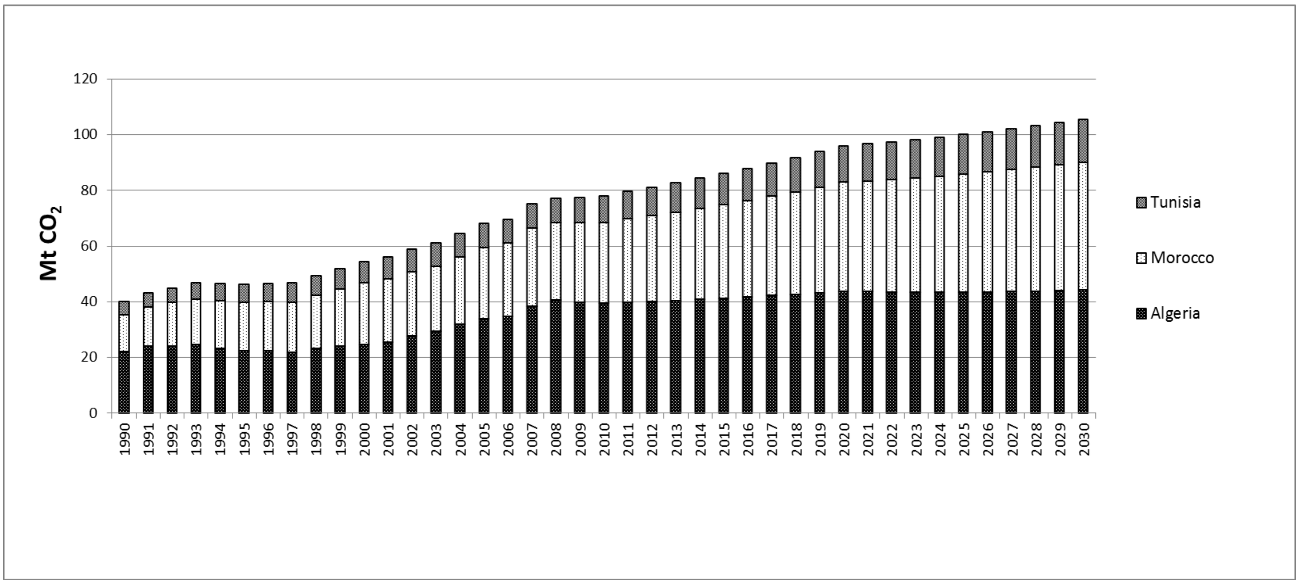

Figure AI.2. Estimated CO_2 emissions (expressed in Mt CO_2) for residential and transport sectors in Maghreb region

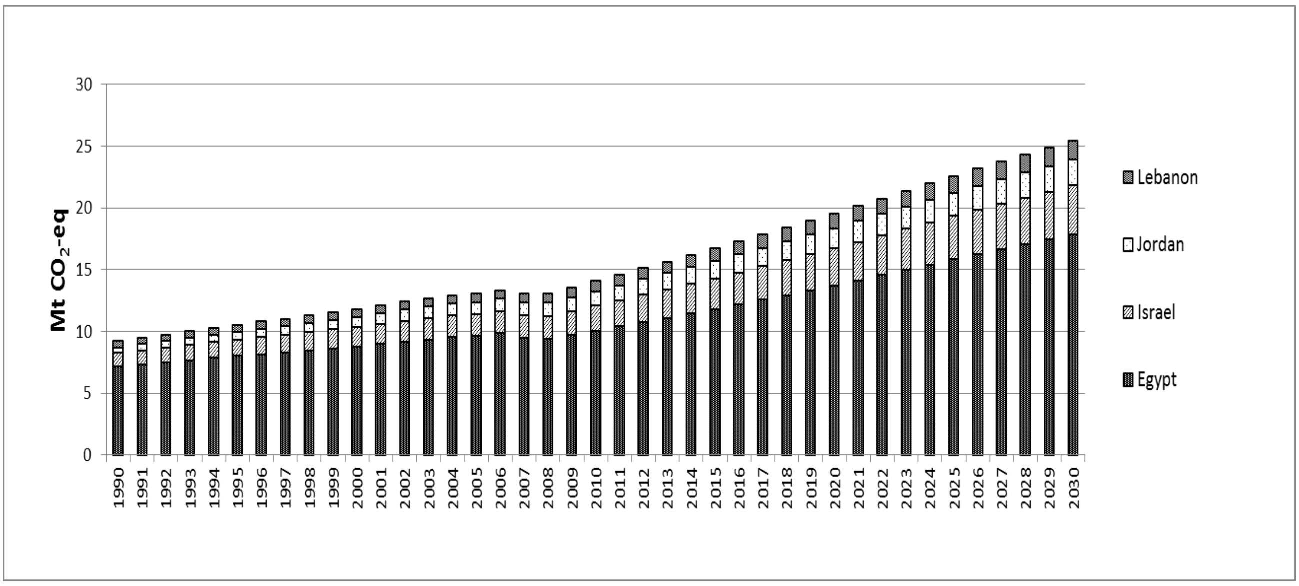

Figure AI.3. Estimated CH_4 emissions (expressed in Mt CO_2-eq) for the 4 CoM sectors in Mashreq region

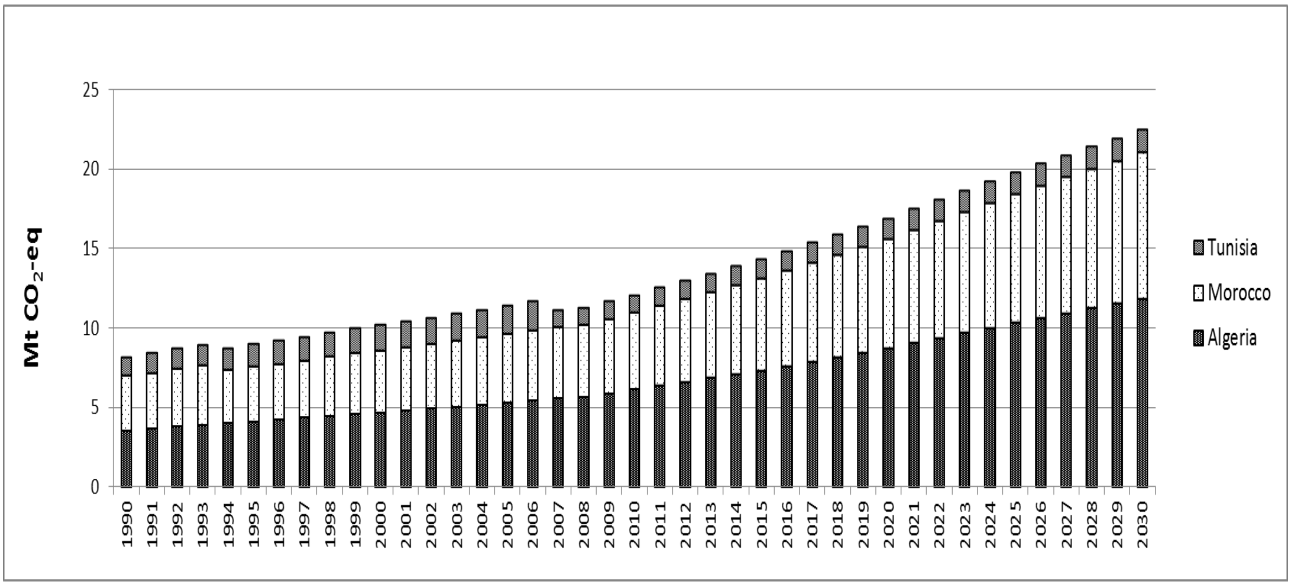

Figure AI.4. Estimated CH_4 emissions (expressed in Mt CO_2-eq) for the 4 CoM sectors in Maghreb region

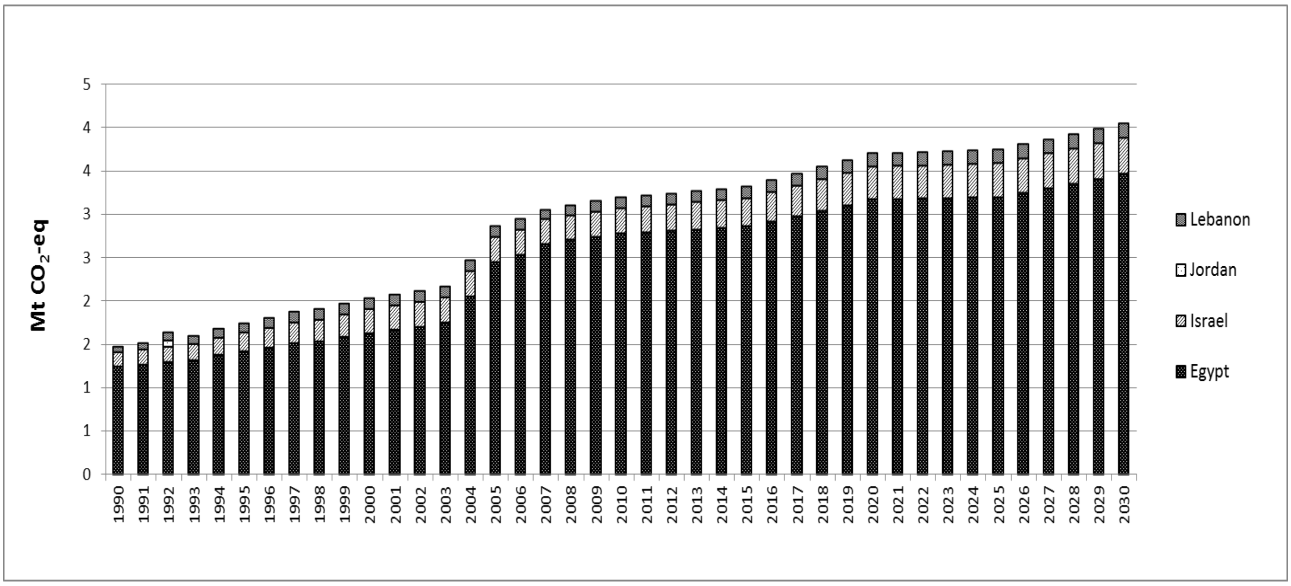

Figure AI.5.Estimated N_2O emissions (expressed in Mt CO_2-eq) for CoM sectors in Mashreq region

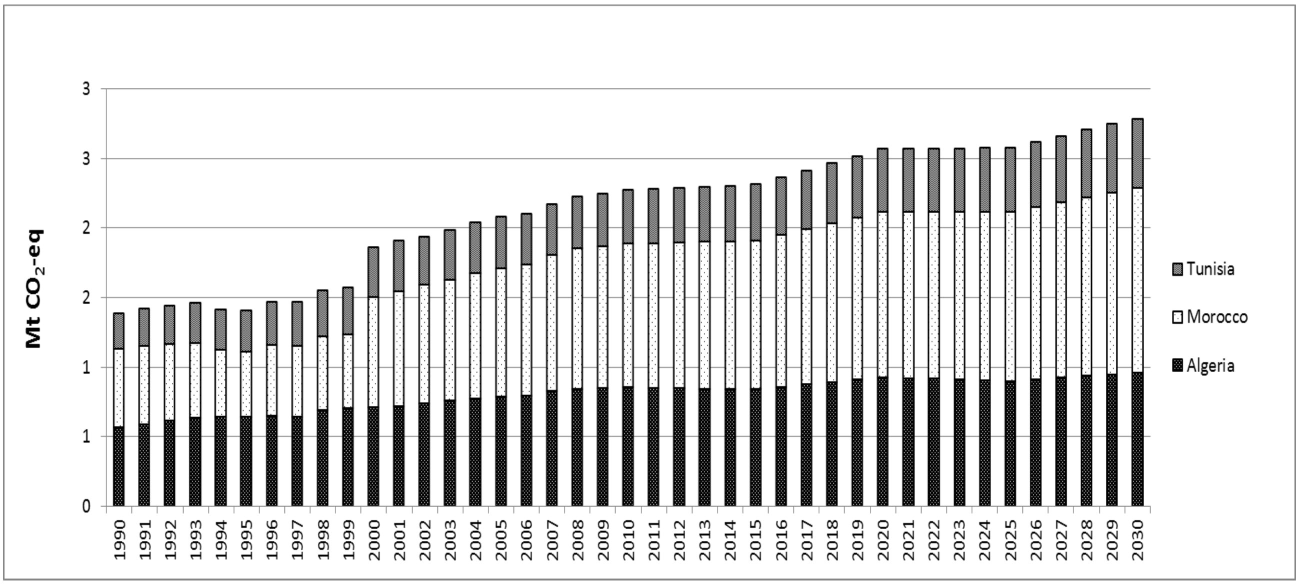

Figure AI.6. Estimated N_2O emissions (expressed in Mt CO_2-eq) for CoM sectors in Maghreb region

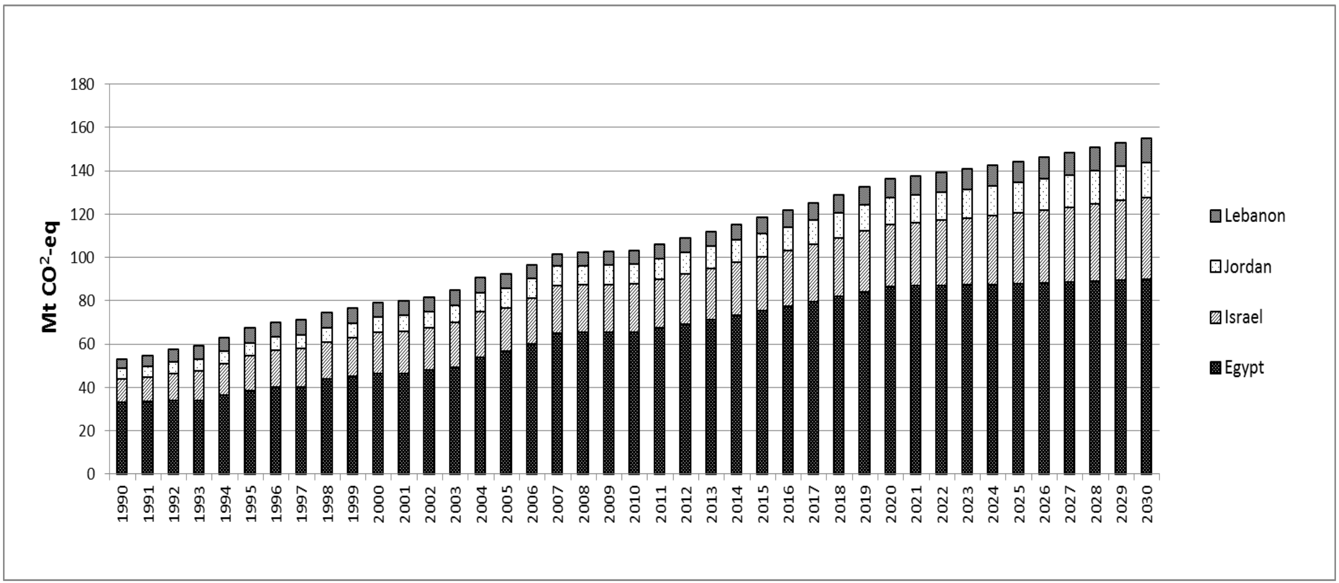

Figure AI.7. Estimated GHG emissions (expressed in Mt CO_2-eq) for CoM sectors in Mashreq region

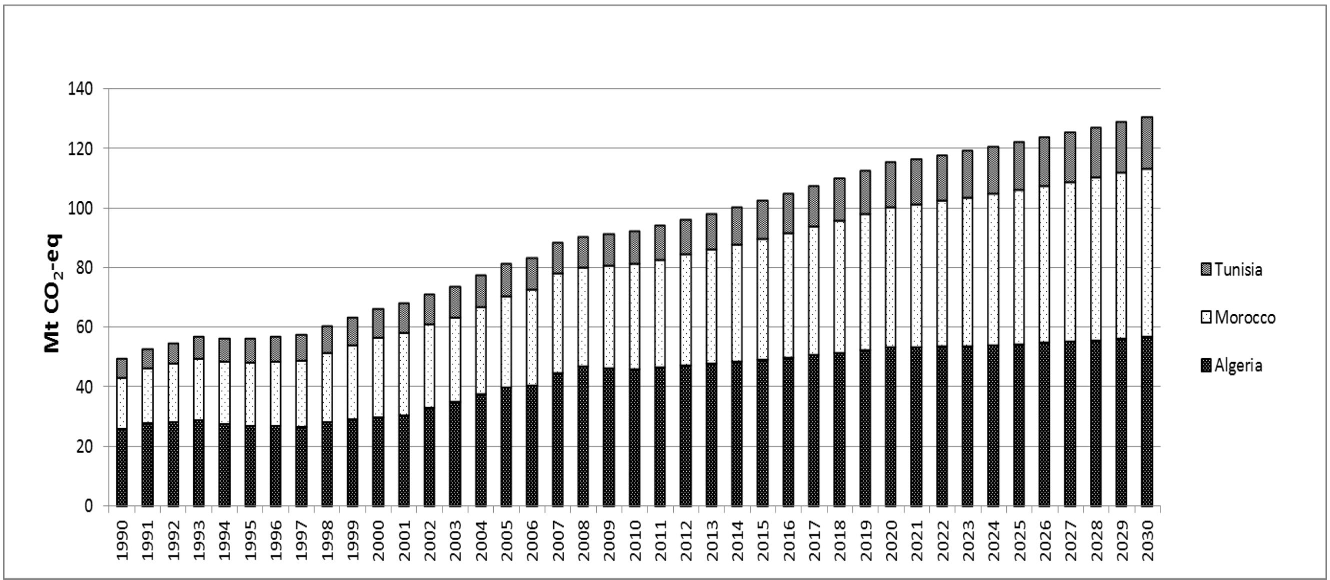

Figure AI.8. Estimated GHG emissions (expressed in Mt CO_2-eq) for CoM sectors in Maghreb region

Annex II. BAU annual national factors in the CoM South Mediterranean countries over the 2002-2030 period

The national BAU factors provided below (Tables AII.1 and AII.2) have been estimated from the historical EDGAR-CIRCE data and the forecast scenario using the POLES model as explained in chapter 2. They correspond to the ratio between the projected emissions in 2030 and the emissions in the given year. They were used to calculate the 2030 BAU coefficients to applied by the municipalities of the current CoM South Mediterranean countries in order to estimate their 2030 emissions. The 2030 BAU coefficients which also account for the urban dimension as explained in section 3.1 are provided in Tables 5 and 6 of the present report.

Table AII.1 : BAU national factors in CoM-South Mediterranean countries in case of CO_2 emission accounting

	BEI year													
Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Algeria	1.60	1.51	1.39	1.31	1.28	1.15	1.09	1.11	1.12	1.12	1.11	1.10	1.08	1.07
Egypt	1.84	1.80	1.62	1.53	1.43	1.29	1.28	1.29	1.30	1.26	1.23	1.19	1.16	1.13
Israel	1.90	1.77	1.73	1.89	1.75	1.67	1.69	1.69	1.69	1.66	1.62	1.58	1.54	1.51
Jordan	2.18	2.07	1.86	1.72	1.78	1.73	1.79	1.77	1.75	1.71	1.66	1.61	1.57	1.52
Lebanon	1.68	1.51	1.54	1.61	1.73	1.82	1.78	1.77	1.75	1.70	1.65	1.61	1.56	1.51
Morocco	1.97	1.95	1.88	1.80	1.72	1.63	1.64	1.61	1.57	1.52	1.48	1.44	1.40	1.36
Palestine*	2.06	1.94	1.80	1.79	1.77	1.71	1.75	1.74	1.73	1.69	1.64	1.60	1.56	1.52
Tunisia	1.94	1.88	1.81	1.76	1.82	1.78	1.74	1.68	1.62	1.57	1.52	1.47	1.43	1.38

	BEI year													
Country	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Algeria	1.06	1.05	1.04	1.02	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.00
Egypt	1.10	1.07	1.04	1.01	0.98	0.98	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00
Israel	1.47	1.43	1.40	1.36	1.33	1.29	1.26	1.23	1.20	1.16	1.13	1.09	1.06	1.02
Jordan	1.48	1.43	1.39	1.35	1.31	1.28	1.24	1.22	1.19	1.15	1.12	1.09	1.06	1.02
Lebanon	1.47	1.43	1.38	1.34	1.30	1.27	1.24	1.21	1.18	1.15	1.12	1.09	1.05	1.02
Morocco	1.32	1.28	1.24	1.20	1.17	1.15	1.13	1.11	1.10	1.08	1.06	1.05	1.03	1.01
Palestine*	1.47	1.43	1.39	1.35	1.31	1.28	1.25	1.22	1.19	1.15	1.12	1.09	1.06	1.02
Tunisia	1.34	1.29	1.25	1.21	1.17	1.16	1.13	1.12	1.10	1.08	1.06	1.05	1.03	1.01

* Because activity data from international statistics are scarce for this country, the national factors are based on annual emission shares per sector in the neighbouring countries.

Table AII.2 : BAU national factors in CoM-South Mediterranean countries in case of GHG emission accounting (using CO_2-eq)

	BEI year													
Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Algeria	1.71	1.62	1.51	1.43	1.40	1.27	1.21	1.22	1.23	1.22	1.20	1.19	1.17	1.16
Egypt	1.86	1.82	1.67	1.58	1.49	1.38	1.37	1.37	1.37	1.33	1.29	1.26	1.22	1.19
Israel	1.93	1.81	1.77	1.92	1.79	1.71	1.73	1.72	1.72	1.67	1.63	1.59	1.55	1.51
Jordan	2.20	2.09	1.89	1.77	1.81	1.76	1.80	1.78	1.75	1.70	1.65	1.61	1.56	1.51
Lebanon	1.74	1.58	1.60	1.66	1.77	1.78	1.81	1.78	1.76	1.71	1.66	1.61	1.56	1.51
Morocco	2.00	1.97	1.91	1.83	1.76	1.68	1.69	1.65	1.60	1.56	1.51	1.47	1.43	1.39
Palestine*	2.10	1.98	1.84	1.82	1.80	1.74	1.78	1.76	1.74	1.69	1.65	1.60	1.56	1.51
Tunisia	1.74	1.69	1.63	1.59	1.63	1.71	1.68	1.63	1.58	1.53	1.48	1.44	1.40	1.36

	BEI year													
Country	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Algeria	1.14	1.12	1.10	1.08	1.07	1.06	1.06	1.06	1.05	1.04	1.04	1.03	1.02	1.01
Egypt	1.16	1.13	1.09	1.06	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.01	1.00
Israel	1.47	1.43	1.40	1.36	1.32	1.29	1.26	1.22	1.19	1.16	1.12	1.09	1.06	1.02
Jordan	1.47	1.43	1.38	1.34	1.30	1.27	1.24	1.21	1.18	1.15	1.12	1.09	1.06	1.03
Lebanon	1.46	1.42	1.38	1.34	1.30	1.27	1.23	1.20	1.17	1.14	1.11	1.09	1.06	1.02
Morocco	1.34	1.30	1.27	1.23	1.19	1.17	1.15	1.13	1.11	1.09	1.07	1.05	1.03	1.01
Palestine*	1.47	1.43	1.39	1.35	1.31	1.27	1.24	1.21	1.18	1.15	1.12	1.09	1.06	1.03
Tunisia	1.32	1.28	1.24	1.20	1.16	1.15	1.13	1.11	1.09	1.07	1.06	1.04	1.03	1.01

* Because activity data from international statistics are scarce for this country, the national factors are based on annual emission shares per sector in the neighbouring countries.

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